WHAT IS CLAIMED IS:

1. An image-processing device comprising:

a quantization threshold produce unit producing a plurality of quantization threshold values corresponding to each of pixels of multivalued image data according to a dither threshold matrix;

a random dither quantize unit quantizing said multivalued image data in multivalues by a random dither process using said quantization threshold values so as to output quantized data; and

a resolution convert binarize unit converting said quantized data into binary image data having a resolution higher than a resolution of said multivalued image data,

wherein said resolution convert binarize unit determines the number of dot-on pixels to be output in a plural-pixel field of said binary image data according to a value of the quantized data of a pixel being processed of said multivalued image data, the plural-pixel field corresponding to said pixel being processed, and controls the order of arranging said dot-on pixels

in said plural-pixel field according to a position on said dither threshold matrix corresponding to said pixel being processed.

2. The image-processing device as claimed in claim 1, wherein said order of arranging said dot-on pixels is controlled so as to form dots of a dot-concentrated type.

3. The image-processing device as claimed in claim 2, wherein said dither threshold matrix contains threshold values so arranged as to form the dots of the dot-concentrated type.

4. The image-processing device as claimed in claim 3, wherein smallest four threshold values among

said threshold values in said dither threshold matrix are arranged at different pixel positions.

5. The image-processing device as claimed in claim 4, wherein the difference between a fourth smallest threshold value and a fifth smallest threshold value in said dither threshold matrix is larger than a step width of said dither threshold matrix.

6. The image-processing device as claimed in claim 3, wherein said dither threshold matrix comprises at least two basic dither threshold matrixes containing the threshold values so arranged as to form the dots of the dot-concentrated type, the two basic dither threshold matrixes being joined in a main scanning direction at a position shifted in a sub-scanning direction.

7. The image-processing device as claimed in claim 1, further comprising an image characteristic extract unit extracting an image characteristic of said multivalued image data, wherein said quantization threshold produce unit controls amplitude of said quantization threshold values according to a characteristic amount output by said image characteristic extract unit.

8. The image-processing device as claimed in claim 7, wherein said quantization threshold produce unit controls the amplitude of said quantization threshold values by switching said dither threshold matrix used for producing said quantization threshold values.

9. The image-processing device as claimed in claim 7, wherein said image characteristic extract unit outputs an edge amount of said multivalued image data as

sāid characteristic amount, and said quantization threshold produce unit makes the amplitude of said quantization threshold values smaller as said edge amount becomes larger.

10. The image-processing device as claimed in claim 9, wherein said image characteristic extract unit outputs the edge amount of said multivalued image data after subjecting the edge amount to an expanding process for expanding an edge field of said multivalued image data.

11. The image-processing device as claimed in claim 9, wherein said image characteristic extract unit outputs the edge amount of said multivalued image data after equalizing the edge amount.

12. The image-processing device as claimed in claim 9, wherein said quantization threshold produce unit produces a constant value as the quantization threshold values when said edge amount output by said image characteristic extract unit is maximum.

13. The image-processing device as claimed in claim 9, wherein said quantization threshold produce unit produces values varying according to a value of said multivalued image data as the quantization threshold values when said edge amount output by said image characteristic extract unit is maximum.

14. The image-processing device as claimed in claim 13, wherein said value of said multivalued image data is an average value in the pixel being processed and adjacent pixels thereof.

15. The image-processing device as claimed in claim 13, wherein said quantization threshold produce unit varies said values varying according to the value of said multivalued image data such that said random dither quantize unit quantizes said multivalued image data in a smaller number of multivalues as the value of said multivalued image data becomes larger.

16. The image-processing device as claimed in claim 15, wherein said resolution convert binarize unit arranges said dot-on pixels in said plural-pixel field according to a predetermined arranging order when said edge amount output by said image characteristic extract unit is maximum.

17. An image-processing device for converting quantized data of multivalued image data into binary image data having a resolution higher than a resolution of said multivalued image data, the quantized data being

obtained by quantizing said multivalued image data in multivalues by a random dither process using a plurality of quantization threshold values produced according to a dither threshold matrix, the image-processing device comprising:

a dot number determine unit determining the number of dot-on pixels to be output in a plural-pixel field of said binary image data according to a value of the quantized data of a pixel being processed of said multivalued image data, the plural-pixel field corresponding to said pixel being processed; and

a dot output position determine unit controlling the order of arranging said number of said dot-on pixels in said plural-pixel field according to a position on said dither threshold matrix corresponding to said pixel being processed.

18. The image-processing device as claimed in claim 17, wherein said order of arranging said number of said dot-on pixels in said plural-pixel field is controlled so as to form dots of a dot-concentrated type.

19. The image-processing device as claimed in claim 17, wherein said dot output position determine unit is supplied with information indicating an edge field so that said dot output position determine unit arranges said dot-on pixels in a plural-pixel field of said binary image data according to a predetermined arranging order, the plural-pixel field corresponding to a pixel in the edge field of said multivalued image data.

20. The image-processing device as claimed in claim 1, further comprising an image-forming unit forming an image according to said binary image data.

21. The image-processing device as claimed in claim 17, further comprising an image-forming unit forming an image according to said binary image data.

22. The image-processing device as claimed in claim 1, further comprising an image-reading unit reading said multivalued image data by optically scanning a subject copy, and an image-forming unit forming an image according to said binary image data.

23. A computer readable recording medium storing program code for causing a computer to process an image, the recording medium comprising:

quantization-threshold-produce program code means for producing a plurality of quantization threshold values corresponding to each of pixels of multivalued image data according to a dither threshold matrix;

random-dither-quantize program code means for quantizing said multivalued image data in multivalues by a random dither process using said quantization threshold values so as to output quantized data; and

resolution-convert-binarize program code means for converting said quantized data into binary image data having a resolution higher than a resolution of said multivalued image data,

wherein said resolution-convert-binarize program code means determines the number of dot-on pixels to be output in a plural-pixel field of said binary image data according to a value of the quantized data of a pixel being processed of said multivalued image data, the plural-pixel field corresponding to said pixel being processed, and controls the order of arranging said dot-on pixels in said plural-pixel field according to a position on said dither threshold matrix corresponding to said pixel being processed.

24. A computer readable recording medium storing program code for causing a computer to convert quantized data of multivalued image data into binary image data having a resolution higher than a resolution of said multivalued image data, the quantized data being obtained by quantizing said multivalued image data in multivalues by a random dither process using a plurality of quantization threshold values produced according to a dither threshold matrix, the recording medium comprising:

dot-number-determine program code means for

determining the number of dot-on pixels to be output in a plural-pixel field of said binary image data according to a value of the quantized data of a pixel being processed of said multivalued image data, the plural-pixel field corresponding to said pixel being processed; and

dot-output-position-determine program code means for controlling the order of arranging said number of said dot-on pixels in said plural-pixel field according to a position on said dither threshold matrix corresponding to said pixel being processed.

25. An image-processing method comprising:

a quantization-threshold-producing step of producing a plurality of quantization threshold values corresponding to each of pixels of multivalued image data according to a dither threshold matrix;

a quantizing step of quantizing said multivalued image data in multivalues by a random dither process using said quantization threshold values so as to generate quantized data; and

a converting step of converting said quantized

data into binary image data having a resolution higher than a resolution of said multivalued image data,

wherein said converting step includes determining the number of dot-on pixels to be output in a plural-pixel field of said binary image data according to a value of the quantized data of a pixel being processed of said multivalued image data, the plural-pixel field corresponding to said pixel being processed, and includes controlling the order of arranging said dot-on pixels in said plural-pixel field according to a position on said dither threshold matrix corresponding to said pixel being processed.

26. The image-processing method as claimed in claim 25, wherein said order of arranging said dot-on pixels is controlled so as to form dots of a dot-concentrated type.

27. The image-processing method as claimed in

claim 25, further comprising an image-characteristic-extracting step of extracting an image characteristic of said multivalued image data, wherein said quantization-threshold-producing step controls amplitude of said quantization threshold values according to a characteristic amount extracted by said image-characteristic-extracting step.

28. The image-processing method as claimed in claim 27, wherein said image-characteristic-extracting step extracts an edge amount of said multivalued image data as said characteristic amount, and said quantization-threshold-producing step makes the amplitude of said quantization threshold values smaller as said edge amount becomes larger.

29. The image-processing method as claimed in claim 28, wherein said image-characteristic-extracting step extracts, as said characteristic amount, the edge

amount subjected to an expanding process for expanding an edge field of said multivalued image data.

30. The image-processing method as claimed in claim 28, wherein said image-characteristic-extracting step extracts, as said characteristic amount, the edge amount being equalized.

31. The image-processing method as claimed in claim 28, wherein said quantization-threshold-producing step produces a constant value as the quantization threshold values when said edge amount extracted by said image-characteristic-extracting step is maximum.

32. The image-processing method as claimed in claim 28, wherein said quantization-threshold-producing

step produces values varying according to a value of said multivalued image data as the quantization threshold values when said edge amount extracted by said image-characteristic-extracting step is maximum.

33. The image-processing method as claimed in claim 32, wherein said value of said multivalued image data is an average value in the pixel being processed and adjacent pixels thereof.

34. The image-processing method as claimed in claim 32, wherein said quantization-threshold-producing step varies said values varying according to the value of said multivalued image data such that said quantizing step quantizes said multivalued image data in a smaller number of multivalues as the value of said multivalued image data becomes larger.

35. The image-processing method as claimed in claim 34, wherein said converting step includes arranging said dot-on pixels in said plural-pixel field according to a predetermined arranging order when said edge amount extracted by said image-characteristic-extracting step is maximum.

36. An image-processing method for converting quantized data of multivalued image data into binary image data having a resolution higher than a resolution of said multivalued image data, the quantized data being obtained by quantizing said multivalued image data in multivalues by a random dither process using a plurality of quantization threshold values produced according to a dither threshold matrix, the image-processing method comprising:

a dot-number-determining step of determining the number of dot-on pixels to be output in a plural-pixel field of said binary image data according to a value of the quantized data of a pixel being processed of said multivalued image data, the plural-pixel field corresponding to said pixel being processed; and

a dot-output-position-determining step of controlling the order of arranging said number of said dot-on pixels in said plural-pixel field according to a position on said dither threshold matrix corresponding to said pixel being processed.

37. The image-processing method as claimed in claim 36, wherein said order of arranging said number of said dot-on pixels in said plural-pixel field is controlled so as to form dots of a dot-concentrated type.

38. The image-processing method as claimed in claim 36, wherein said dot-output-position-determining step arranges said dot-on pixels in a plural-pixel field of said binary image data according to a predetermined arranging order, the plural-pixel field corresponding to a pixel in an edge field of said multivalued image data.

39. An image-forming device for converting input multivalued image data of a low resolution into output binary image data of a high resolution, the device comprising:

an edge-level calculating unit calculating an edge level from the input multivalued image data just before undergoing a γ correction;

a γ-correction unit performing a gradation correction by using a printer γ selected according to said edge level;

a quantizing unit quantizing said input multivalued image data into quantized data by a multivalued random dither using a first dither threshold matrix selected according to said edge level; and

a dot position control unit converting said quantized data into the number of dot-on pixels in unit pixels of said high resolution, and controlling the positions of said dot-on pixels in said unit pixels according to a second dither threshold matrix.

40. The image-forming device as claimed in claim 39, wherein said second dither threshold matrix

contains threshold values so arranged as to form dots of a dot-concentrated type, and said dot position control unit outputs the dots to pixels in said unit pixels corresponding to positions in an ascending order of said threshold values.

41. An image-forming device for converting input multivalued image data of a low resolution into output binary image data of a high resolution, the device comprising:

an edge-level calculating unit calculating an edge level from the input multivalued image data just before undergoing a γ correction;

a γ-correction unit performing a gradation correction by using a printer γ selected according to said edge level;

a quantizing unit quantizing said input multivalued image data into quantized data by a multivalued random dither using a first dither threshold matrix selected according to said edge level and an output mode; and

a dot position control unit converting said

quantized data into the number of dot-on pixels in unit pixels of said high resolution, and controlling the positions of said dot-on pixels in said unit pixels according to a second dither threshold matrix.

42. The image-forming device as claimed in claim 41, wherein said first dither threshold matrix is switched to a dither threshold matrix having different threshold values according to said output mode.

43. The image-forming device as claimed in claim 41, wherein said first dither threshold matrix is switched to a dither threshold matrix having a different arrangement of threshold values according to said output mode.

44. The image-forming device as claimed in claim 41, wherein the dither threshold matrixes are switched to dither threshold matrixes having different sizes according to said output mode.

45. The image-forming device as claimed in claim 39, wherein said first dither threshold matrix has larger amplitude as said edge level becomes smaller.

46. The image-forming device as claimed in claim 41, wherein said first dither threshold matrix has larger amplitude as said edge level becomes smaller.

47. The image-forming device as claimed in claim 39, wherein said edge level is obtained by quantizing an edge amount in a plurality of levels, the

edge amount being calculated from said input multivalued image data just before undergoing said γ correction.

48. The image-forming device as claimed in claim 41, wherein said edge level is obtained by quantizing an edge amount in a plurality of levels, the edge amount being calculated from said input multivalued image data just before undergoing said γ correction.

49. The image-forming device as claimed in claim 47, wherein threshold values used in quantizing said edge amount are changed according to a result of a white-background judgment judging whether or not a pixel being processed is a white-background field.

50. The image-forming device as claimed in

claim 48, wherein threshold values used in quantizing said edge amount are changed according to a result of a white-background judgment judging whether or not a pixel being processed is a white-background field.

51. The image-forming device as claimed in claim 49, wherein said white-background judgment judges that the pixel being processed is the white-background field, when more than a predetermined number of pixels having input pixel data less than a predetermined value exist in a predetermined field centered around the pixel being processed.

52. The image-forming device as claimed in claim 50, wherein said white-background judgment judges that the pixel being processed is the white-background field, when more than a predetermined number of pixels having input pixel data less than a predetermined value exist in a predetermined field centered around the pixel

being processed.

53. The image-forming device as claimed in claim 39, wherein said edge level is maximized, when data of a pixel being processed is more than a predetermined value.

54. The image-forming device as claimed in claim 41, wherein said edge level is maximized, when data of a pixel being processed is more than a predetermined value.

55. The image-forming device as claimed in claim 47, wherein said edge level is maximized, when data of a pixel being processed is more than a predetermined value.

56. The image-forming device as claimed in claim 48, wherein said edge level is maximized, when data of a pixel being processed is more than a predetermined value.

57. The image-forming device as claimed in claim 39, wherein after said edge level is subjected to an expanding process to be selected as a largest edge level from among edge levels in a predetermined expansion field, said edge level is subjected to a contracting process to be selected as a smallest edge level from among edge levels in a predetermined contraction field.

58. The image-forming device as claimed in claim 41, wherein after said edge level is subjected to an expanding process to be selected as a largest edge level from among edge levels in a predetermined expansion field, said edge level is subjected to a

contracting process to be selected as a smallest edge level from among edge levels in a predetermined contraction field.

59. The image-forming device as claimed in claim 57, wherein sizes of said expansion field and said contraction field are changed according to an output mode.

60. The image-forming device as claimed in claim 58, wherein sizes of said expansion field and said contraction field are changed according to said output mode.

61. The image-forming device as claimed in claim 59, wherein the size of said contraction field is

smaller than the size of said expansion field.

62. The image-forming device as claimed in claim 60, wherein the size of said contraction field is smaller than the size of said expansion field.

63. The image-forming device as claimed in claim 59, wherein said edge level is not subjected to said contracting process in an output mode aimed at a text image.

64. The image-forming device as claimed in claim 60, wherein said edge level is not subjected to said contracting process in an output mode aimed at a text image.